Privacy in Domestic Environments

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Abstract
While there is a growing body of research on privacy, most of the work puts the focus on information privacy. Physical and psychological privacy issues receive little to no attention. However, the introduction of technology into our lives can cause problems with regard to these aspects of privacy. This is especially true when it comes to our homes, both as nodes of our social life and places for relaxation. This paper presents the results of a study intended to capture a part of the phenomenology of privacy in domestic environments.

Keywords
Privacy, user study, domestic environments

ACM Classification Keywords
H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous; K.4.1. Computer and Society: Public Policy Issues—Privacy.

General Terms
Human Factors

Introduction and Motivation
The importance of privacy and its implications for the design of new technology are widely acknowledged [13]. Perceived privacy is an important factor for the acceptance of new technology. While privacy is not the main goal of users of information technology, failure to

maintain privacy can cause more severe outcomes for the user than the breakdown of goal-related functionality [8]. Furthermore, treating privacy as an add-on feature instead of considering it from the beginning causes technological challenges for the design of technology [8, 13]. As technology increasingly permeates our homes, making them 'smart', the focus of designers needs to shift more towards the inhabitants' needs while realizing that our homes, as central nodes of our social lives, are much more complex than the well-understood environments we work in [9, 10].

Westin describes four functions of privacy: *personal autonomy*, *self-evaluation*, *emotional release*, as well as *limited and protected communication* [14]. Newell generalizes these functions into psychological *maintenance* and *development* [12]. Privacy enables psychological maintenance as it protects an entity from external threats, like cognitive, affective, or information overload. It is, therefore, a coping mechanism for stress and as such a direct prerequisite for restorative environments [7]. It is necessary for personal development as it provides a space where experimentation without judgment is possible [12]. This intention to control how others perceive oneself links privacy to impression management [11].

Many researchers in different disciplines have recognized the importance of addressing privacy in the home. Alexander [2] dedicates two of his architectural design patterns solely to aspects of privacy within the domestic space and mentions them as influences in numerous other patterns. Aipperspach et al. [1] observe that the boundaries between the workplace and the home start to disappear due to the introduction of more technology into the home, thus endangering the restorative characteristics of the home. Designers should empower users to control the amount of stimulation from the environment. Edwards and Grinter [3] name privacy as an important factor in the design of aware homes. Harrison et al. [4] see privacy as an important aspect in ubiquitous computing.

In their study of location-aware mobile messaging, Iachello et al. [5] found that control over location disclosure was seen as a prerequisite for the utility of the messaging application. Furthermore, study participants displayed less inhibition to disclose their location to close friends or family than to individuals not falling into those categories. This relationship of closeness and information disclosure has also been observed by Judge et al. [6] in their study of the 'family window', an application connecting families living far apart through a permanent video link. The study also provided more evidence for the importance of controlling one's social interactions as well as others' knowledge of oneself.

The pilot study described in this paper was motivated by this need for better models of privacy in the home. First, the main research question and hypotheses are stated. The study setup and results are discussed, followed by the discussion of the results. The paper concludes with a summary of the contributions of this paper and recommendations for future work.

Purpose of the Study

The works described in the previous section do a good job at linking the effects of technology to the psychological theories presented. However, they still fall short of contributing to a holistic model of privacy in domestic environments as they observe human behavior *after* introducing new technology into the lives of the target

population. This makes it impossible to distinguish between behavior that was present *before* introducing the technology and behavior *elicited by* the technology.

Three hypotheses about privacy phenomena in the home emerge from previous research:

- Absence of control and awareness exacerbate the perceived threat from privacy intrusions.
- The perceived threat from an intrusion of privacy is mitigated by the closeness of the relationship with the intruder.
- Privacy behavior is not limited to location, but rather extends to activity as well.

The design of this study was informed by these hypotheses and intended to capture privacy phenomena in domestic environments. The study is not intended to validate the hypothesis but to provide a foundation for a future work in that direction. Emphasis was put on trying to determine the relationships between privacy and contextual factors such as location and activity. Furthermore, the study was meant to explore individual experiences of privacy in the home. Due to space restrictions, these findings are not provided here.

Method

The study was conducted as an online survey. Participants were recruited from the Human Subject Pool of the Psychology Department at Virginia Tech as well as through a graduate student listserv. Participants from the Human Subject Pool received research credits for their participation. In total, 108 responses were collected, out of which 103 were complete (69 females and 34 males). The participants included 94 undergraduate students, four graduate students, two staff members, two members of the Corps of Cadets or Reserve Officer's Training Corps, and one participant who did not specify his or her occupation. The median age of participants was 19 years, with a minimum age of 18 and a maximum age of 32 (M=19.95, SD=2.12). Of the participants, 44 lived in a dorm, 50 in an apartment, and eight in a house. The number of cohabitants ranged from zero to five (M=1.79, SD=1.19). 56 participants shared the kitchen, 37 shared a bedroom.

The questionnaire had four sections, *Demographic*, *Privacy and Location*, *Privacy and Activity*, and *Privacy and Experience.* In the Demographic section, participants were asked about their age, gender, occupation, living situation, and cultural background.

The Privacy and Location section was designed to provide insight about the relationship between privacy and locations within the home. To that end, participants were presented with four scenarios matching two conditions (present and absent) with two locations (kitchen and bedroom). They described under which circumstances they would feel comfortable with someone looking around in the respective location under the specific condition. They were furthermore instructed to rank their comfort based on the identity of the actor.

In the Privacy and Activity section, they described under which circumstances they would feel uncomfortable with someone either overhearing a phone conversation or witnessing them kissing someone. They also ranked their discomfort based on the identity of the witness.

Finally, in the Privacy and Experience section, participants recounted two incidents from their own experi-

ence, one in which they were successful in achieving privacy and on where they were not. Due to space restrictions, these results are not reported here.

Results

The qualitative data was analyzed using grounded theory, sorting responses into different categories based on the key terms present in the responses. During coding, differences emerged between male and female participants. However, since the population was not evenly divided into the two groups and since the membership of a response of a category was binary, the use of inferential statistics on the qualitative data was dismissed in favor of descriptive statistics.

Privacy and Location

Participants were presented with four scenarios. The first two asked participants under which circumstances they would be comfortable if someone (the 'actor') was going through their kitchen cabinets and opened their fridge with them present (scenario 1a) or absent (scenario 1b). The second two asked participants under which circumstances they would be comfortable if somebody else opened drawers or looked around in their bedroom with them present (scenario 2a) or absent (scenario 2b). The circumstances under which participants were comfortable with the scenarios are quite different (table 1).

While 39.81% of participants would be comfortable under any circumstances in scenario 1a, the situation is reversed in scenario 2b where 40.78% of participants would be comfortable under no circumstances. In scenarios 1b and 2a, most participants described specific circumstances attached with certain conditions rather than giving categorical answers.

Many participants stated that they have to know the actor to feel comfortable with a proposed. Tnumber of these mentions of familiarity is much higher in scenarios 1b and 2a than scenarios 1a and 2b as can be seen in table 2. However, this is easily explained by the lower number of categorical answers for those scenarios.

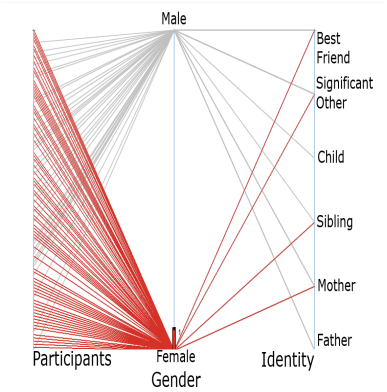
	any	**none**	**specific**
Scenario 1a			
# Participants	41	1	61
Percent of Total	39.81%	0.97%	59.22%
Scenario 1b			
# Participants	9	7	87
Percent of Total	8.74%	6.80%	84.47%
Scenario 2a			
# Participants	4	13	86
Percent of Total	3.88%	12.62%	83.50%
Scenario 2b			
# Participants	0	42	61
Percent of Total	0.00%	40.78%	59.22%

table 1: Circumstances under which participants were comfortable with a proposed scenarios.

Scenario 1a		***Scenario 1b***	
# Participants	37	*# Participants*	63
%of Total	35.92%	*% of Total*	61.17%
Scenario 2a		***Scenario 2b***	
# Participants	55	*# Participants*	33
% of Total	53.40%	*% of Total*	32.04%

table 2: Participants mentioning they require to know the actor to feel comfortable with a proposed scenario.

Participants placed further restrictions onto the circumstances under which they would be comfortable with a scenario (table 2). Participants placed more restrictions on the identity of the actor in the scenarios located in the bedroom than in those located in the kitchen. This is especially true for the restriction of the actor to a specific gender, which only occurred in scenarios 2a



Participants were asked to imagine someone was looking around their bedroom while they were present. They were then given multiple options for the identity of the actor and asked to rank those identities from most comfortable to least comfortable. The graph above shows whom participants were most comfortable with in that situation. The red selected lines show female participants, the grey lines show male participants. It is noteworthy that female participants were never most comfortable with their father being the actor. This is further reflected by the restrictions shown in table 3.

and 2b. The restriction of the actor's gender was only placed by females, which is reflected in the ranking of the identity of the actor for scenario 2a. For example, females rank their father lower than males with Z(-3.05, 101), P=0.002, significant at α=0.01.

	identity	emergency	gender
Scenario 1a			
Mentioned by	14	0	0
Percent of Total	13.59%	0.00%	0.00%
Scenario 1b			
Mentioned by	15	4	0
Percent of Total	14.56%	3.88%	0.00%
Scenario 2a			
Mentioned by	27	0	7
Percent of Total	26.21%	0.00%	6.80%
Scenario 2b			
Mentioned by	27	9	5
Percent of Total	26.21%	8.74%	4.85%

table 3: Some participants restricted the identity or gender of the actor to feel comfortable, or required an emergency to feel comfortable with a proposed scenario.

Privacy and Activity

Participants were asked under which circumstances they would feel uncomfortable with someone overhearing a phone conversation or seeing them kiss. The responses revealed differences between the two activity-scenarios and the location-based scenarios, as well as between each other. While participants still placed constraints on circumstances based on the actor's identity, they were less likely to answer categorically. There were also differences between the two different activities. In the phone scenario, the conversation content has a big influence on whether participants are comfortable with someone else overhearing it (table 4). In contrast, the intensity of the kiss factors into whether participants are comfortable with being seen (table 5).

any	none	specific	identity	content
11	8	84	25	61
10.68%	7.77%	81.55%	24.27%	59.22%

table 4: Circumstances and factors for participants to be comfortable with someone overhearing a phone conversation.

any	none	specific	identity	intensity
19	12	64	26	14
18.45%	11.65%	62.14%	25.24%	13.59%

table 5: Circumstances and factors for participants to be comfortable with someone seeing them kiss.

Discussion and Conclusions

The study was conducted to capture privacy phenomena in domestic environments. The results suggest that lack of awareness and control of a situation exacerbates the perceived threat from privacy. Comparing responses for scenario 1a with scenario 1b and scenario 2a with scenario 2b, shows that the change from present and aware to absent and unaware causes discomfort. This is reflected in the change from not placing conditions to placing conditions (scenario 1a to 1b) and change from placing conditions to complete rejection of the situation (scenario 2a to 2b). This also shows an increased need for privacy from the kitchen to the bedroom. Results also suggest that the perceived threat of a privacy intrusion is mitigated by the relationship to the intruder in both location and activity scenarios. However, in scenario 2b this mitigation seems to be less successful. This is manifested in the relatively high number of categorical rejections of the scenario. The results also demonstrate that different activities have different privacy requirements. These privacy requirements seem to be specific to the activity, as can be seen from the differences between scenarios 3 and 4.

However, there are some shortcomings. The high number of undergraduate students and a resulting low median age of participants limit the transferability of results to the general public. The survey is not extensive enough to result in a holistic model of privacy in domestic environments. The use of scenarios may push the answers into a certain direction. The long-form answers in the Privacy and Experience section may paint a different picture than the short-form answers discussed. Despite its shortcomings, the results of this study are promising and are an initial step towards a holistic model of privacy in domestic environments. They can inform the direction of future work, e.g. investigating the connection between the mitigating effects of a relationship on perceived threat to privacy and the strength of the relationship. Moreover, it has to be determined whether interrelationships between the privacy needs for locations and those for activities exist. Future work has to address how a privacy model for domestic environments can be created out of the data collected. This is especially true for qualitative data due to the difficulty of translating and integrating this kind of data into both theory and reusable models.

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